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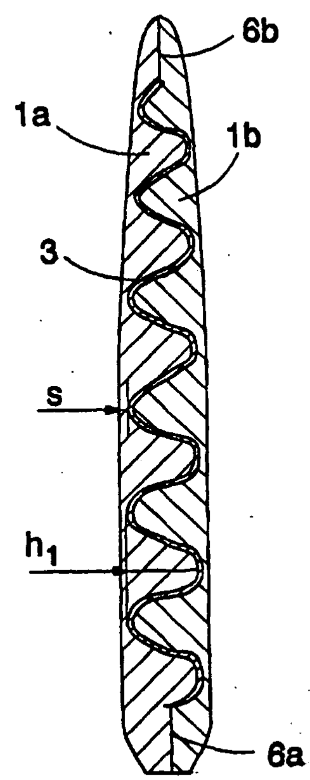
(54) Title: BLADE STRUCTURE AND METHOD OF MANUFACTURING BLADE

(57) Abstract

The invention relates to a method of manufacturing a blade structure of an ice hockey stick or the like, according to which method a layer made of a fibre-reinforced plastic material and having a wavelike cross section is formed inside the core of the blade, the layer forming a three-dimensional stiffening piece (3) inside the core. The invention further relates to a blade structure of an ice hockey stick or the like comprising a core and laminate layers (10a, 10b) to constitute the outer surface of the core on the sides of the blade. According to the inventive idea, a stiffening piece (3) made of a fibre-reinforced plastic material and having a wavelike cross section is formed inside the core of the blade.



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BLADE STRUCTURE AND METHOD OF MANUFACTURING BLADE

The invention relates to a method of manufacturing a blade structure of a hockey stick or the like, in which method laminate layers of a fibre-reinforced plastic material are laminated on the sides of the core of the blade to constitute the outer surface of the blade.

The invention further relates to a blade structure of a hockey stick or the like comprising a core and laminate layers of a fibre-reinforced plastic material formed on the sides of the core as the outer surfaces of the blade.

Conventionally, the blades of hockey sticks and bandy sticks or the like are made of wood. Originally, a blade made of one piece of wood was used but advance in glues and gluing techniques has enabled manufacture of blades wherein several sheets of wood glued together combine to form a blade. However, blades made entirely of wood are not sufficiently strong; therefore, sheets of wood have been combined with fibre-reinforced plastic layers in a manner disclosed in US Patent 4,537,398, for example. In such a case, the blade is formed of two or more sheets of wood with a fibreglass-reinforced material arranged therebetween at the gluing stage. Furthermore, the blade is laminated with layers of fibreglass on both sides after being given a desired shape. An advantage of the solution is low weight and relatively high rigidity achieved thereby. However, a problem of this otherwise useful blade structure is poor strength particularly in connection with of slap shots. The rigidity of the blade quickly decreases in use. Furthermore, the lower edge of the blade, i.e. the edge facing the playing surface, wears down fast, which can cause the fibres of the laminate layer to break and the lamination to be torn. As a result, the structure of the blade is substantially impaired. Attempts have been made to improve the mechanical strength of the blade structure by replacing the wooden core with a suitable core made of a thermoplastic plastic material. Layers of a fibre-reinforced material have then been laminated on the surfaces of such a core in order to achieve a final rigidity and strength for the blade, the structure enabling a significant improvement in the strength of the blade against impact and mechanical wear. However, the weight/rigidity ratio of the structure is not competitive with a blade structure based on a core made of sheets of wood; therefore, such sticks are not very popular among top players. The structure of a blade consisting entirely of plastic is disclosed in US Patent 4,059,269, for example. Further, FI Patent 65018 teaches that the

core of the blade is made of polyurethane foam. For reinforcement, fibreglass tape is wound around such a core and the manufacturing process is completed by further extruding a layer of polyester plastic all over the surface of the preform of the blade, the polyester plastic thus constituting the surface layer of the blade. A preferable weight/rigidity ratio can be achieved by making the core of the blade of a foamed plastic material but a problem that now arises is insufficient shear strength; consequently, the blade is too weak to withstand heavy impact that it is subjected to particularly in connection with slap shots. A further drawback common to all blade structures described above is that they are slow and complex to manufacture.

US Patent 5,407,195 discloses a solution wherein bridge members made of a fibre-reinforced plastic material are formed between first and second face members of the blade to connect said face members. Thus, an integrated blade structure is achieved. Such a solution allows good strength and rigidity but the problem is that the structure is difficult to manufacture. Hence, the solution disclosed in the publication is not suited for industrial mass production and cannot thus be utilized in manufacturing competitively priced sticks.

An object of the present invention is to provide a novel method of manufacturing a blade structure of a stick used in ice hockey or the like enabling a simpler and less expensive way to manufacture blades. A further object of the invention is to provide a blade structure of a stick which has good mechanical properties with regard to its weight and is easy to manufacture.

The method of the invention is characterized by forming inside the core of the blade a reinforcing piece made of a fibre-reinforced plastic material and having a wavelike cross section.

Furthermore, the blade structure of a stick of the invention is characterized in that a reinforcing piece made of a fibre-reinforced plastic material and having a wavelike cross section is formed inside the core of the blade.

The idea underlying the invention is that a stiffening piece made of a fibre-reinforced plastic material and having a wavelike cross section is formed inside the core of the blade, preferably along the entire length of the blade. In such a manner, a three-dimensional stiffening piece can be formed in the space defined by the side surfaces of the core of the blade.

Furthermore, an underlying idea of a first preferred embodiment of

the invention is that the core of the blade is formed by using at least one core profile, a wavelike surface having been formed on at least one side of the core profile preferably substantially over the entire length of the blade. Against this wavelike surface, a layer of a fibre-reinforced plastic material, such as fibreglass or other such fibres having great strength, and plastic matrix, such as resin, is arranged on the blade to form a wavelike, three-dimensional stiffening piece to receive shear forces. An underlying idea of a second preferred embodiment of the invention is that the core profile is formed by gluing together two separate parts with corresponding wavelike surfaces having been formed on the counter surfaces of the parts arranged to face each other. The fibre-reinforced layer of the core is then arranged between these parts when the parts are glued together. As the fibre-reinforced layer arranged between the parts becomes sandwiched between the parts, the fibre-reinforced layer obtains a cross section that corresponds to the wavelike shape of the surface of the parts. Such a fibre-reinforced material impregnated with epoxy resin or some such adhesive substance thus forms a reinforcing piece having a substantial importance for the stiffness and shear strength of the blade. Furthermore, an underlying idea of a third preferred embodiment of the invention is that the core profile is formed of a thermoplastic plastic material and that the bonding agent of the stiffening piece is of a thermoplastic plastic material, in which case the stiffening piece is welded against the wavelike side surface of the core profile by using high-frequency microwaves. Furthermore, an underlying idea of a fourth preferred embodiment of the invention is that a layer of fibre-reinforced plastic material is arranged against the wavelike surface of the side of the core profile, whereafter a suitable plastic material is cast on the other surface of said layer to constitute one side of the core. Furthermore, an underlying idea of a fifth preferred embodiment of the invention is that the core profile is arranged at least at the lower edge of the blade to extend over the lamination layers of the sides of the blade, whereby a wear-resistant part is formed for the blade to withstand wear and receive impacts. An underlying idea of a sixth preferred embodiment of the invention is that in order to make the assembly easier, the core profile comprises a space into which the shaft of the stick, which is tapered at its lowermost end, can be arranged.

An advantage of the invention is that it enables a simpler way to manufacture strong and rigid blades of sticks. Thanks to the invention, a three-

dimensional stiffening piece can be formed in the blade structure more easily. Joining the structural parts of the blade and attaching the blade to the shaft can be carried out even in only one pressing stage wherein the blade simultaneously receives a desired level of curvature. Similarly, the assembly of a structure wherein the joining of the core profile and the stiffening piece takes place by welding can be carried out even in one stage. Compared with the conventional sticks, the invention allows competitive manufacturing costs of blades while the service life and operating characteristics of the sticks can be significantly improved compared with those of the conventional solutions. A further advantage is that even in the cores of blades greatly differing in curvatures and profiles only one core profile can be used since the core profile can be shaped quite freely. By extending the core profile made of a highly impact- and wear-resistant material over the laminate layers of the sides of the blade, an edging to protect the rest of the blade structure can be formed as the outer surface of the desired edges.

The invention will be described in closer detail in connection with the accompanying drawings, in which

Figure 1a is a schematic side view of a structure of a core profile used in a blade structure of the invention,

Figure 1b is an enlarged view of a similar structure to that in Figure 1a seen from the direction of arrow A,

Figures 2a to 2c show schematic cross sections of the core of the blade structure of the invention at different points of the blade,

Figures 3a to 3c schematically show alternative sectional forms of the profiles used in the core of the blade structure of the invention,

Figure 4 shows a schematic cross section of a feasible structure of the blade structure of the invention ,

Figure 5 schematically shows a cross section of a core profile,

Figure 6a shows a stiffening profile made of a fibre-reinforced plastic material and having a wavelike cross section to be arranged in the core of the blade and, and

Figure 6b is a cross-sectional view of another feasible blade structure whereto the stiffening profile in accordance with Figure 6a has been applied.

Figure 1 is a simplified side view of a core profile 1 used in a blade structure in accordance with the invention. It is to be immediately noted that

although the figures and their description only show different blade structures of an ice hockey stick, the invention can also be readily applied to sticks used for example in playing bandy, rinkball, street hockey and the like. In addition, the invention is suited for use in the sticks of goalies and other players. The core profile 1 comprises a lower edge 2a facing the playing surface, an upper edge 2b opposite to the lower edge 2a, a front tip edge 2c, and a rear edge 2d facing the shaft of the stick. The core profile 1 further comprises sides 2e and 2f. The core of the blade is formed, in a manner described in connection with the figures below, by the core profile and a stiffening piece 3 made of fibre-reinforced plastic to be arranged against the core profile. On both sides 2e and 2f of the outer surface of the core, laminate layers made of fibre-reinforced plastic, shown in Figure 6b, for example, are formed in a manner known per se. There can be a plurality of such superposed reinforcing layers and the orientation of the fibres of the different layers, for example, can be used for adjusting the characteristics that affect the stiffness and strength of the blade in a desired manner. For example, by laminating a reinforcing layer at an angle of 45° with respect to the longitudinal axis of the blade, the torsional rigidity of the blade can be increased, and by laminating on top of such a layer a further reinforcing layer whose fibres are mainly in the direction of the longitudinal direction of the blade it is provided with good strength and bending stiffness. Also the order in which the layers are superposed can be used to affect the characteristics of the laminate layers of the blades.

The core profile of the blade preferably comprises two separate parts 1a and 1b whose sides arranged to face each other are formed as a wavelike surface, as can be seen from Figure 1b. The parts determine the desired dimensions for the blade. Furthermore, projecting portions 4a and 4b defining a space 5 for the attachment of the downwardly-tapering shaft can be formed at the edge 2d facing the shaft. Such projecting portions are of no particular importance with respect to the strength of the attachment between the blade of the stick and the shaft because the actual attachment of the blade to the shaft is carried out in connection with the lamination of the sides of the outer surface of the blade. The projecting portions, on the other hand, are preferable in view of manufacture since they act as "guides" that make the shaft and the blade easier to position.

Impacts against the blade are mainly received by the wavelike stiffening piece formed in the core and the laminate layers on the outer

surfaces of the blade, so, except for providing support to the stiffening piece, the core profile in itself does not necessarily have any great importance for the strength and rigidity characteristics of the blade. The core profile is, however, preferably made of a plastic material having good impact and wear resistance by injection moulding or casting, for example. The parts of the core profile can be made of reaction plastic, such as polyurethane, or thermoplastic plastic, such as acrylonitrile butadiene styrene (ABS). Naturally, also other plastic materials suitable for the purpose can be used. In order to keep the blade lightweight, plastic light in itself or a plastic material foamed by an appropriate blowing agent is preferably used as the material of the core profile. It is preferable to use a foamed plastic material with a weight by volume of 0.7 or less. The plastic material foams in regions where the thickness of the material is at its highest. Correspondingly, at points where the structure is thin, i.e. between the bottom of the wavelike configuration and a side, the material is dense, forming a relatively sturdy layer between the laminate layer of the side of the blade and the stiffening piece inside the core.

Against the wavelike side of the core profile, the fibre-reinforced material is arranged together with resin. For reasons of cost, it is preferable to use fibreglass in the stiffening piece, but other reinforcing materials, carbon fibre and aramid fibre, for example, can of course be used. The fibre can be woven fabric, staple fibre, braid, non-woven fibre-reinforced mat, co-directional matrix or fibre-reinforced material in any appropriate form for the purpose. Preferably, glass fabric having a thickness of approximately 0.2 to 0.5 millimetres is used. Furthermore, it is preferable to use reinforced fabric in which the number of fibres is the same in the longitudinal and transverse directions or in which the number of fibres in the traverse direction is higher than in the longitudinal direction, the ratio being 70%/30%, for example.

Figure 2a is a cross-sectional view of the blade in accordance with Figure 1a taken along line B - B. As is apparent from transverse sections C - C and D - D shown in Figures 2b and 2c, the cross section changes toward the tip of the blade. The blade is thicker at the heel, where impact on the blade is greater on account of the moment arm due to the length of the blade than at the tip of the blade. The heel of the blade can be provided with more flexural rigidity when height h_1 of the parts 1a and 1b of the core profiles and thus also of the waves of the stiffening piece 3 is greater at the heel of the blade than height h_2 of a corresponding wave at the tip of the blade. However, the stick is

still sufficiently flexible at the tip of the blade, which is important for the handling of the instrument, such as the puck or the ball, for example. The wavelike configuration of the fibre-reinforced stiffening piece 3 in the core can be formed such that the blade is provided with exactly the desired characteristics at a given point. The wavelike configuration does not need to change in a linear manner between the free end of the blade and the edge facing the shaft but, if necessary, the height of a wave can be changed in the longitudinal direction of the blade according to the desired characteristics. It is also feasible to affect the characteristics of the blade by directing the wavelike configuration in a desired manner with respect to the central axis of the blade, at a certain angle with respect to the central axis, for example. In some cases it may be feasible to arrange the wavelike configuration of the stiffening piece even transversely with respect to the longitudinal axis of the blade. Furthermore, owing to the handling of the instrument and impact caused by the playing surface, the cross section is larger at the lower edge than at the upper edge of the blade. Preferably, the wavelike configuration of the core profile has at its upper and lower ends substantially straight portions 6a and 6b. It is not necessary to extend the stiffening piece 3 to these portions; it is sufficient that it covers the wavelike portion. An edging is thus formed which is simple to shape, if necessary, and which is highly wear-resistant. The edging serves to provide a wear-resistant rail at the upper and lower edges of the blade, whereby neither impacts directed to the blade in this direction nor wear caused by the playing surface decreases the strength of the blade. The surface layers of the sides of the blade that are commonly laminated by fibreglass technique in a manner known per se are situated at a distance from the edges of the blade, whereby they are prevented from being torn as a result of wear. The core profile made of a wear-resistant plastic material thus extends at least at the lower edge of the blade over the laminate layers of the sides of the blade. The blade can also be formed such that the core profile forms the outer portion of the blade also at the tip of the blade. Furthermore, as can be seen from Figures 2a to 2c, there is distance s between the stiffening piece 3 formed inside the core and the outer surfaces of the sides 2f and 2e of the core, in other words the stiffening piece 3 does not, in the final blade structure, come into direct contact with the laminate layers of the outer surfaces of the blade.

The core profile of the blade can be made sufficiently large, in other

words its length and height can be dimensioned so as to enable blades of highly different shapes to be manufactured of the same core profile. Hence, different types of sticks do not necessitate unique core profiles but variations with highly different curvatures and profiles can be made using one profile. Within certain limits, also a finished stick can be shaped according to the personal preferences of a player by grinding the heel or the tip of the blade for example at points that are, for the sake of clarity, indicated in an exaggerated manner in broken dotted lines 7a and 7b in Figure 1a. After shaping, the shaped points are sufficiently bevelled to ensure that the laminate layers of the sides will not become loose.

It is also feasible to form the core profile of the blade such that the reinforcing laminates for the outer surfaces of the core profile, or at least some of them, are attached already in connection with the manufacture of the core profile. Such a procedure is highly preferable when the core profile is made of polyurethane or the like by so-called reaction casting. The solution allows fewer stages of operation and enables the blade to be manufactured even faster. Further, the stiffening piece can be produced in advance against the wavelike side of the first core profile and only in connection with the assembly of the stick is the stiffening piece joined for example by gluing one part of the core together with the other part. Furthermore, the core structure of the blade in accordance with the invention can be formed such that one part or both parts of the core profile is/are made of a thermoplastic plastic material, whereby in connection with the assembly of the core a laminate layer is arranged against the wavelike side surface of the core structure, the plastic matrix of the laminate layer being made of a thermoplastic plastic material. Such a pre-produced laminate layer is then heated, whereby it sets according to the wavelike surface of the core profile. Next, the structure is subjected to high-frequency waves that cause the laminate layer and the core profile to become welded together. This technique enables the assembly of the blade to be carried out during one stage such that the stiffening piece arranged between two core profiles is heated, and, simultaneously, the parts of the core profile are both welded together and to the stiffening piece. This is thus one way to manufacture the three-dimensional stiffening piece made of a fibre-reinforced plastic material inside the core of the blade. The solution is highly suitable for industrial production. It is also feasible to manufacture the blade core such that the pre-produced stiffening piece containing a thermoplastic

plastic material is heated and arranged against the wavelike surface of the core profile, whereafter the core profiles are joined together by means of an appropriate adhesive agent. The parts of the core profile can have a desired curvature level in advance or they can be heated to a shaping temperature simultaneously with the heating the stiffening piece by using for example high-frequency waves or some such appropriate heating method.

Figures 3a to 3c show further feasible shapes for the core profile by way of example and in a simplified manner. In the present application, the wavelike configuration thus also refers to other cross-sectional shapes than merely the sine-wave-like configuration shown in Figures 2a to 2c. Hence, the wavelike surface of the core profile and the cross-sectional shape of the stiffening piece of the core obtained thereby can correspond for example to the shapes of the truncated triangle or rounded triangle shown in Figure 3a. Furthermore, the wavelike configuration can be a rectangular wave, as shown in Figure 3b. The waves do not have to be symmetrical, as can be seen from Figure 3c. In view of the manufacture of the blade structure it is preferable that the wavelike configuration is formed by using sufficient bevelling and radius of curvature, whereby the fibre-reinforced layer is able to set properly against the wavelike surface of the core profile. It is to be noted that the wavelike configuration does not need to have the same shape along the elevation or the lengthwise direction of the blade but the wavelike configuration may change according to the desired characteristics.

Figure 4 is a simplified sectional view of a solution for forming the core of the blade in accordance with the invention. As distinct from the previous figure, only one part 1a of the core profile is used in this solution. The stiffening piece 3 is formed by arranging the fibre-reinforced material against the wavelike surface of the part 1a for example by pressing it by means of overpressure or a suitably shaped counterpart. Next, a second part 1c of the core is cast of a suitable plastic material. Preferably some relatively light plastic, for example polyurethane or the like, is used for the casting. The fibre-reinforced material can be pressed against the wavelike surface of the core profile also for example by means of the pressure generated by the plastic material cast in the same stage of operation. Furthermore, an edging 8 to receive impact and prevent wear can be cast on the lower edge 2a of the core in a separate stage, or it can possibly be a pre-fabricated insert. Next, the sides 2e and 2f of the core are laminated in a normal manner, whereby the

blade obtains its final strength and durability.

Figure 5 further shows a cross section of a feasible core profile. The core profile now comprises one piece whose sides comprise the wavelike surfaces. The fibre-reinforced layers can now be arranged on both sides of the core profile 1. Next, a suitable plastic material, such as polyurethane, is cast on the sides before the sides of the core formed in this manner are laminated. Also in this case the core profile can extend over the laminate layers of the sides.

Figures 6a and 6b show a further possibility to form a three-dimensional fibre-reinforced layer inside the core. In this possibility, a stiffening piece 9 of the blade of the kind shown in Figure 6a and having a wavelike cross section is made in advance of a fibre-reinforced plastic material in a separate stage. The wavelike surfaces of the stiffening piece 9 can be filled by casting a suitable plastic material such that a core that is substantially even in its outer surfaces can be achieved for the blade. At the same time, the filling stuff supports the structure making it even more rigid. For example foamy plastic, such as polyurethane, can be used to fill the waves but also other light plastic materials can be used. Since the wavelike stiffening piece 9 is relatively rigid in itself, it can be arranged inside a mould and the filling stuff can be simultaneously cast on both sides thereof. Another alternative is to fill the waves in two separates stages, in which case the stiffening piece can be supported against a suitable counter surface during the cast. Forming the core of the blade by using such a pre-produced stiffening piece is quite fast and the method is well-suited for industrial mass production. As can be seen from Figure 6a, there is filling stuff also between the crests of the waves of the stiffening piece and the laminate layers 10a and 10b of the sides, whereby a somewhat flexible layer s is obtained between the rigid wavelike reinforcing structure and the laminate layer of the outer surface of the blade to improve the player's "feel" for the playing instrument. Figure 6b further shows separate wear-resistant pieces 11a and 11b preferably forming rail-like parts along the entire length of the blade that extend over the laminate layers of the sides of the blade, thus protecting the rest of the blade structure against wear and impact. Such wear-resistant pieces can be arranged in the structure in connection with laminating the sides of the blade, for example. Furthermore, inserts made of wood, fibre-reinforced plastic or other such suitable material, for example, can be arranged in the blade structure.

The drawings and the related description are only intended to illustrate the inventive idea. The invention can vary in its details within the scope of the claims. Hence, in the structures disclosed in Figures 2a to 2c, the core can be made of more than two parts. By arranging between the parts for example a core profile of the kind disclosed in Figure 5 having a wavelike surface design on both sides, two wavelike stiffening pieces having the same direction can be formed for the blade structure. In such a case, however, the height of the waves of the stiffening pieces is smaller, of course. The blade structure of the invention can also be applied in connection with replaceable blades. It is further noted that the core profile does not have to be made of a plastic material but wood can also be used to produce profiles that enable manufacture of rigid and strong blades. A wooden core profile can be bent in advance to a desired curvature. The wavelike surface can be formed thereto by milling, for example. The parts of the core profile can also be differently coloured, whereby the wavelike configuration characteristic of the blade is apparent seen from the tip of the blade and, naturally, in the cross section of the blade.

CLAIMS

1. A method of manufacturing a blade structure of a hockey stick or the like, in which method laminate layers (10a, 10b) of a fibre-reinforced plastic material are laminated on the sides of the core of the blade to constitute the outer surface of the blade, **c h a r a c t e r i z e d** by forming inside the core of the blade a stiffening piece (3) made of a fibre-reinforced plastic material and having a wavelike cross section.

2. A method as claimed in claim 1, **c h a r a c t e r i z e d** by the core of the blade comprising at least one pre-produced core profile (1), a layer made of a fibre-reinforced plastic material being arranged against of at least one side with a wavelike surface of the core profile to form in the core of the blade the stiffening piece (3) with a wavelike cross section corresponding to the surface of the core profile (1).

3. A method as claimed in claim 2, **c h a r a c t e r i z e d** by forming the core of the blade of two separate parts (1a, 1b), wavelike surfaces being formed on the sides of the parts that are to be arranged to face each other, by arranging between said parts (1a, 1b) a layer of a fibre-reinforced plastic material, and by pressing the parts (1a, 1b) against each other, whereby the fibre-reinforced plastic material sandwiched therebetween obtains a wavelike shape of cross section corresponding to the surface of the parts.

4. A method as claimed in claim 2, **c h a r a c t e r i z e d** by using one core profile (1), a layer of a fibre-reinforced plastic material being arranged against the wavelike surface of the side of the core profile, and by casting from a plastic material a portion to the other surface of said layer to constitute one side of the core.

5. A method as claimed in any one of the preceding claims, **c h a r a c t e r i z e d** by joining different structural layers and other structural parts contained in the blade in one stage of operation, and by simultaneously providing the blade with a desired level of curvature.

6. A method as claimed in any one of claims 2 to 5, **c h a r a c t e r i z e d** by using a wide and long core profile (1) of which blade structures with different profiles and curvatures are formed.

7. A method as claimed in any one of claims 2 to 6, **c h a r a c t e r i z e d** by using a core profile made of a highly impact- and wear-resistant material, such as ABS plastic, and by arranging the core profile

(1) to extend at least at a bottom edge (2a) of the blade over the laminate layers (10a, 10b) of the sides of the blade, whereby the core profile (1) forms the outer part of the blade in this direction.

8. A method as claimed in claim 3, **characterized** by manufacturing the stiffening piece (3) of a thermoplastic plastic material and reinforcing material in advance, by heating the stiffening piece and arranging it between the parts (1a, 1b), and by heating a structure thus formed by means of high-frequency waves, for example, whereby the parts (1a, 1b) and the stiffening piece (3) become welded together.

9. A method as claimed in claim 1, **characterized** by casting a suitable plastic material around the pre-produced stiffening piece (3) with a wavelike cross section so that said plastic material forms at least the side surfaces of the core thus provided.

10. A blade structure of a hockey stick or the like comprising a core and laminate layers (10a, 10b) of a fibre-reinforced material formed on the sides of the core as the outer surfaces of the blade, **characterized** in that a wavelike stiffening piece (3) made of a plastic material and having a wavelike cross section is formed inside the core of the blade.

11. A blade structure as claimed in claim 10, **characterized** in that the core of the blade comprises at least one pre-produced core profile (1), and that at least one side of the core profile (1) has a wavelike surface substantially over the entire length of the blade, and that a layer made of a fibre-reinforced plastic material arranged to form a three-dimensional stiffening piece (3) having a corresponding cross section to the wavelike surface of the core profile in the core is arranged against the wavelike surface of the core profile (1).

12. A blade structure as claimed in claim 11, **characterized** in that the core profile (1) comprises two parts (1a, 1b), that the surfaces of the sides to be arranged to face each other are formed to have a wavelike form, and that a layer made of a fibre-reinforced plastic material is arranged between the wavelike surfaces, the layer being arranged to form the three-dimensional stiffening piece (3) in the core.

13. A blade structure as claimed in claim 11, **characterized** in that the core comprises one core profile (1), that the stiffening piece (3) made of a fibre-reinforced plastic material and corresponding to the wavelike surface of the core profile is arranged against the wavelike surface of the core

profile, and that the other part of the core is cast from a plastic material on the opposite side of the stiffening piece.

14. A blade structure as claimed in claim 11, **characterized** in that the surface of both sides of the core profile (1) is wavelike, and that the stiffening piece (3) made of a fibre-reinforced plastic material and having a wavelike cross section is arranged against the two sides.

15. A blade structure as claimed in claim 12, **characterized** in that the parts (1a, 1b) and the plastic matrix of the stiffening piece (3) are made of a thermoplastic plastic material, and that the parts (1a, 1b) and the stiffening piece (3) are welded together.

16. A blade structure as claimed in any one of claims 11 to 15, **characterized** in that the core profile (1) is arranged to extend at least at a bottom edge (2a) of the blade over the laminate layers (10a, 10b) of the blade to constitute the outer surface of the blade in this direction.

17. A blade structure as claimed in any one of claims 11 to 16, **characterized** in that the core profile (1) comprises projecting portions (4a, 4b) at an edge (2d) facing the shaft for the mounting of the shaft, the projecting portions being arranged to define a space (5) for the tapering lower portion of the shaft of the stick.

18. A blade structure as claimed in claim 10, **characterized** in that portions to constitute the side surfaces of the core are cast from a suitable plastic material around the pre-produced stiffening piece (3).

19. A blade structure as claimed in any one of claims 11 to 14, **characterized** in that the core profile (1) is made of polyurethane.

20. A blade structure as claimed in any one of claims 11 to 14, **characterized** in that the core profile (1) is made of wood.

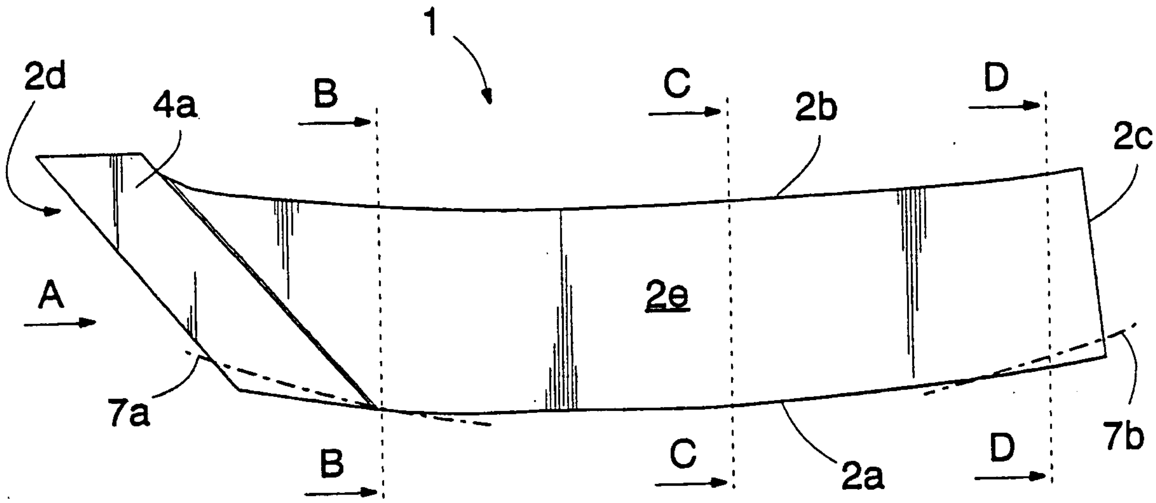

FIG. 1a

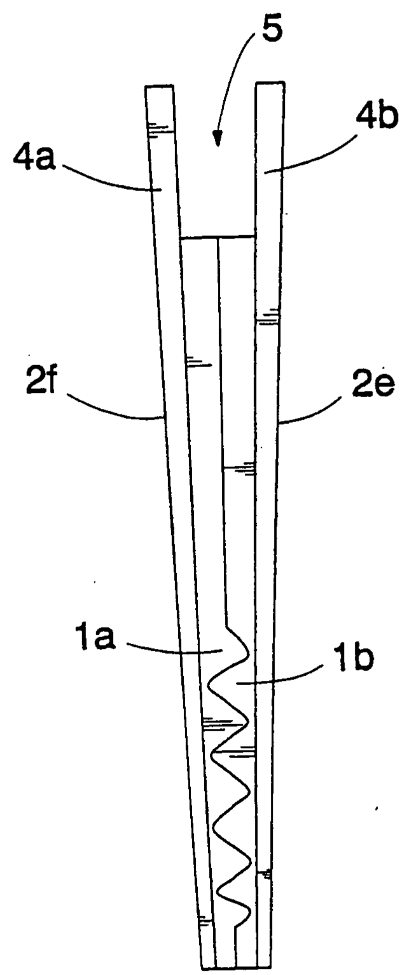

FIG. 1b

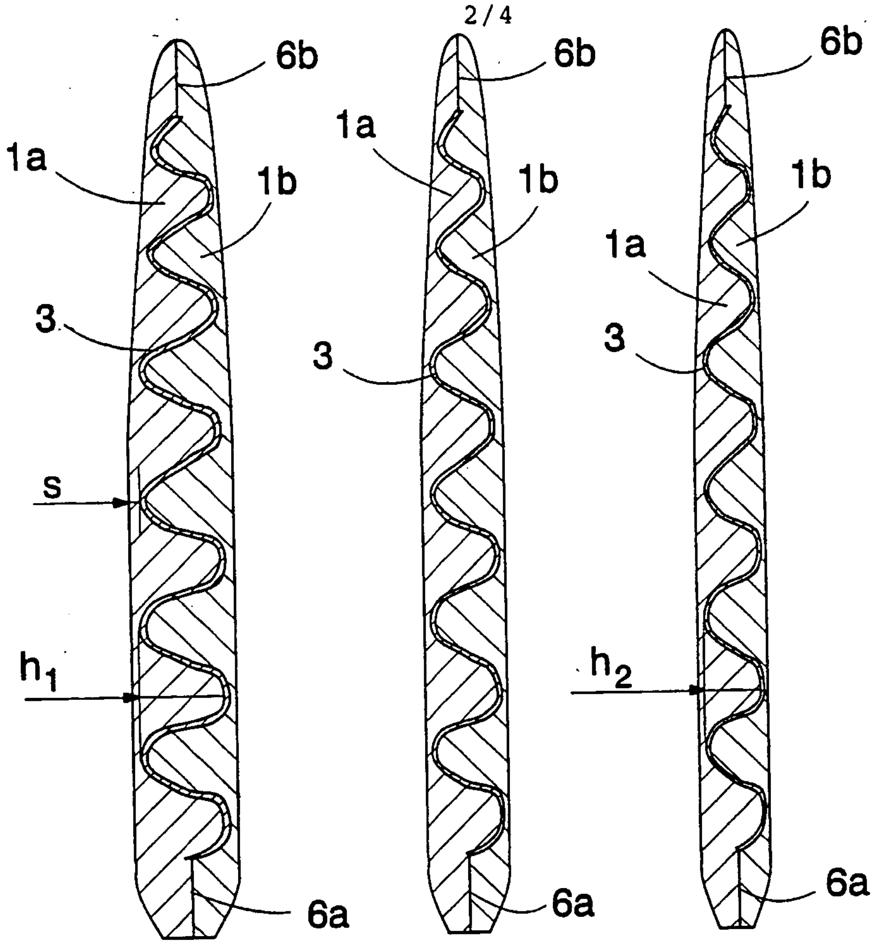

FIG. 2a FIG. 2b FIG. 2c

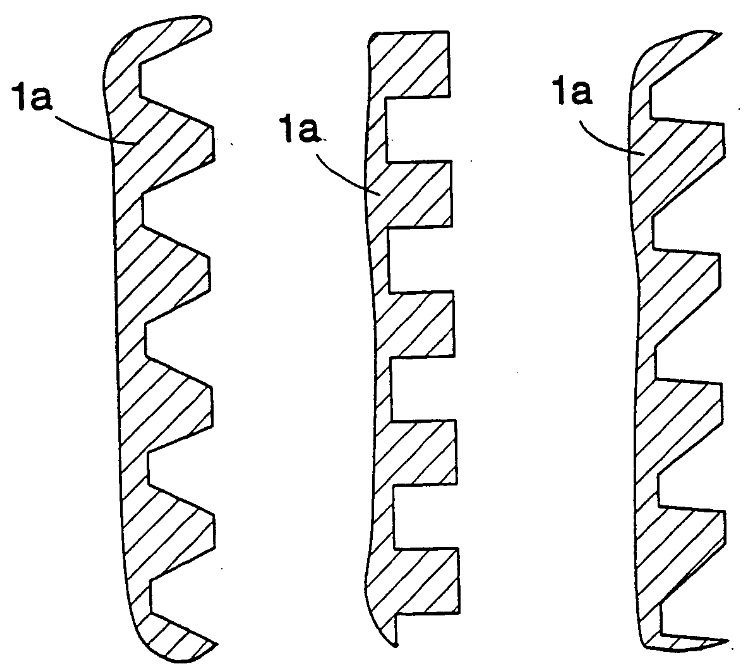

FIG. 3a FIG. 3b FIG. 3c

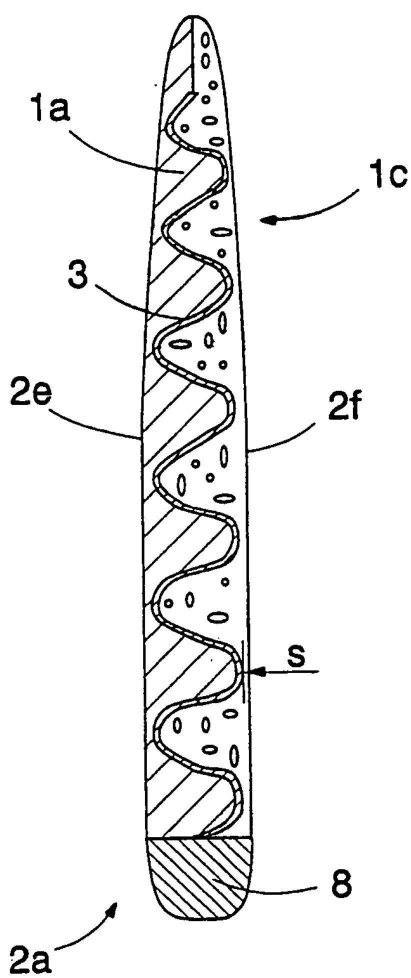

FIG. 4

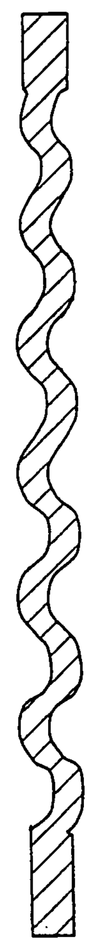

FIG. 5

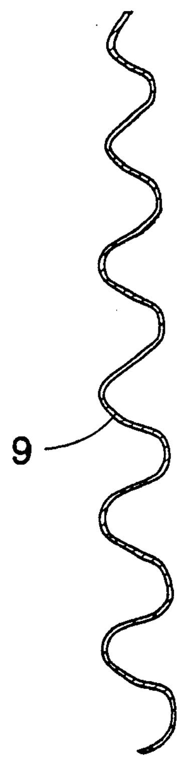

FIG. 6a

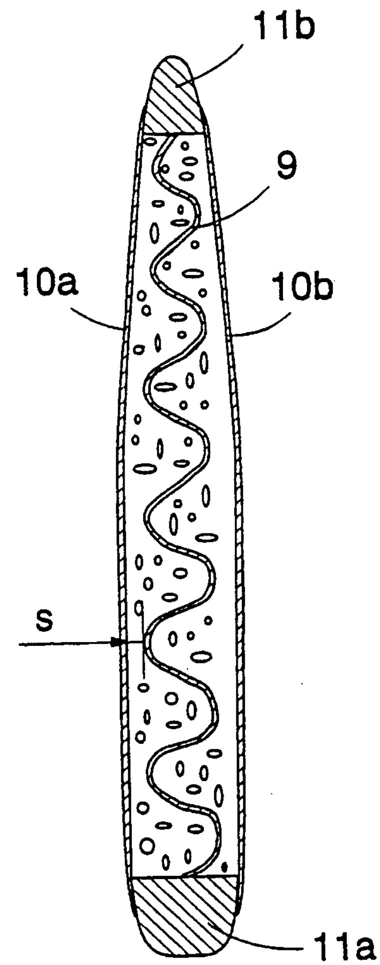

FIG. 6b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00992

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: A63B 59/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: A63B, B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4059269 A (A.-J. TIITOLA), 22 November 1977 (22.11.77), figures 1-3, abstract --	1-20
A	US 5407195 A (A.-J. TIITOLA ET AL), 18 April 1995 (18.04.95), figures 1,2,4, abstract --	1-20
A	US 4537398 A (R. SALMINEN), 27 August 1985 (27.08.85), figure 12, abstract --	1-20
A	US 3982760 A (A.-J. TIITOLA), 28 Sept 1976 (28.09.76), figures 1-3, abstract -- --------	7,16

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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- "O" document referring to an oral disclosure, use, exhibition or other means
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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 March 2000	16 March 2000 (16.03.00)
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Anna Sandberg / MR Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/12/99

International application No.
PCT/FI 99/00992

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